IFW AF 2121

Docket No. Kermani 14

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Examiner: J. Hirl
Art Unit: 2121

INVENTORS: Bahram G. Kermani

APPLICATION NO. 09/427,802

FILED: October 27, 1999

TITLE: FUZZY LOGIC SYSTEM WITH EVOLUTIONARY VARIABLE RULES

CERTIFICATE OF MAIL

I hereby certify that this paper is being deposited with the U.S. Postal Service as First Class Mail, postage prepaid, in an envelope addressed to Commissioner for Patents, MAIL STOP AF, P.O. Box 1450, Alexandria, VA 22313-1450, Attention: Board of Patent Appeals and Interferences on July 12, 2004.

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Attention: Board of Patent Appeals and Interferences

APPELLANTS' BRIEF

This brief is in furtherance of the Notice of Appeal filed in this case on May 10, 2004.

This brief is transmitted in triplicate.

July 12, 2004

1. REQUIRED FEE

The requisite fee ($330.00) set forth in §1.17(f) is enclosed.

2. REAL PARTY IN INTEREST

The present application is assigned to Agere Systems Inc., having its principal place of business at 1110 American Parkway NE, Allentown, Pennsylvania 18109. Accordingly, Agere Systems Inc. is the real party in interest.

3. RELATED APPEALS AND INTERFERENCES

The appellant, assignee, and the legal representatives of both are unaware of any other appeal or interference which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

4. STATUS OF CLAIMS

A. Claims canceled: None

B. Claims withdrawn from consideration but not canceled: None

C. Claims pending: 1-20

D. Claims allowed: None

E. Claims rejected: 1-20

F. Claims appealed: 1-20

Appealed claims 1-20 as currently pending are attached as Appendix A hereto.

5. STATUS OF AMENDMENTS

An amendment after final was filed in the present case, but was not entered. A Reply under 37 C.F.R. §1.111 was filed on November 17, 2003 and resulted in the final Office Action appealed herein. A Reply under 37 CFR §1.116 was filed on May 10, 2004, but did not result in allowance by the Examiner.

6. SUMMARY OF THE CLAIMED INVENTION

The present invention relates to a fuzzy logic system with evolutionary variable rules. According to the present invention, the features, qualifiers, and operators of rules, and the rules themselves, are continually generated and evolved using **genetic algorithms**, based on real-time data. This invention is especially useful in stock market forecasting and, in particular, day-trading wherein the pertinent data may change many times over a short period of time.

First, a random set of rules (a population of chromosomes) is generated using a random selection from each of the categories of operators, features, cases, and qualifiers. Next, the population of chromosomes are evolved to improve their fitness function in a known manner. The fitness function is a cost function that penalizes the algorithm if it renders non-compliant results, i.e., results that do not logically follow the trend of the input data.

Once the fitness function **plateaus** for the population (i.e., **ceases to improve)** the resultant rule (a chromosome) is stored, e.g., in a bin, thereby creating a storage location or "binning pool" in which "optimized" rules are accumulated. The chromosomes then go

through further generation (initialization) and evolution to improve their overall fitness function. The chromosomes that are subjected to this further evolution may be a set of newly generated chromosomes (including chromosome(s) from the previous evolutionary session). This process is repeated until adding more chromosomes to the optimized rule pool does not improve the overall fitness of the pool. At this point the algorithm may be stopped and the best chromosomes then define the rules of the system. For example, if it is presumed that a optimized chromosome pool population can contain 15 chromosomes, then once 16 chromosomes have been established, an evaluation is made and the 15 fittest chromosomes are kept while the worst of the 16 is deleted.

Thus, the fuzzy logic system of the present invention creates fuzzy rules in real-time and updates the fuzzy rules dynamically. This is accomplished by using **genetic algorithms** to continually optimize the features, qualifiers, cases, and operators of the fuzzy rules until they **plateau**. The fuzzy logic system may be utilized in applications requiring constantly-updated fuzzy rules and also in applications where fuzzy rules are difficult to pre-define due to a large quantity of input data, such as, for example, stock market forecasting.

The Hung Reference (U.S. Patent No. 5,727,130)

Hung teaches a genetic algorithm for constructing and tuning a fuzzy logic system. More specifically, Hung deals with an optical character recognition (OCR) application, whereby training sets of optimized moment and variant character data are used to evaluate fuzzy logic systems modeled with parameters produced through the use of a genetic

algorithm. The fuzzy logic systems are evaluated and given a score to input back into the genetic algorithm, which uses the score in a reproduction process to produce new chromosomes for reinsertion into the fuzzy logic system models. Of relevance to the present invention is the fact that the chromosomes are evaluated to determine their performance within a model of the fuzzy logic system to be developed. The evaluation process includes a comparison to a threshold value which, if met, terminates the process.

The Chidambaran et al. Reference

Chidambaran et al. teach the use of genetic programming to create a computer program that approximates the relationship between the price of a stock option, the terms of the option contract, and the properties of the underlying stock price that forms the basis for the stock option. Using genetic programming, the authors of the Chidambaran et al. reference claim that they can create a computer program that achieves a better solution to the problem (approximating the relationship between the option price, the option contract and the underlying stock price) than the "Black-Scholes" option pricing model, a widely accepted option pricing theory used in financial markets at the time of the writing of the Chidambaran et al. reference. In accordance with Chidambaran et al., the steps of the evolutionary program are repeated for a "pre-specified number of times" and then the steps are terminated.

7. ISSUES

A. ISSUE INVOLVING CLAIMS 1-20

1. Whether the Examiner improperly rejected the claims because the cited prior art fails to teach or suggest the process of evolving random rules to improve their fitness function until the overall fitness function of the rules plateaus.

8. GROUPING OF CLAIMS

A. Claims 1-20 stand or fall together.

9. ARGUMENT

What this appeal boils down to is a dispute as to whether "plateauing" as claimed in the present invention is synonymous with the meeting of a threshold as described in Hung. Applicant maintains that they are different, for the reasons set forth herein.

A threshold is simply a "time-out" mechanism. When it is reached, all further processing stops. A plateau, by contrast, is an indication of a local maximum. Neither reaching a plateau nor reaching a threshold guarantee that a global maximum has been reached. However, if a threshold is reached, and the function is still increasing beyond the threshold, it is a certainty that the local maximum has not been reached. Therefore, reaching a plateau is a stronger indicator than reaching a threshold.

A. The Examiner improperly rejected claims 1-8 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,727,130 to Hung.

In item 9 on page 7 of the final Office Action, the Examiner rejected claims 1-8 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,727,130 to Hung.

The hybridizing of fuzzy logic and genetic algorithms is the topic of textbook explanation and neither Hung nor the present invention can claim such broad concepts as being within the scope of their respective inventions. Hung uses such hybridized elements for the specific problem of optical character recognition (OCR).

The present claims are directed specifically to the derivation and generation of an optimized rule set for a fuzzy logic system. As described in the present application, these have specific application in the field of market prediction. Most importantly, Hung is devoid of any teaching or suggestion of continuing of the evolutionary process until the fitness function of the rules cannot be further improved, i.e., become substantially constant, indicating that it has reached a <u>plateau</u>.

The Examiner asserts that column 4, lines 27-67 through column 5, lines 1-8 teaches the evolving of random rules using a genetic algorithm to improve their fitness function until the overall fitness function of the rules plateaus. However, it is clear from reading these cited sections that, contrary to the assertion of the Examiner, <u>plateauing</u> is not taught or suggested by Hung. Specifically, Hung teaches the setting of a threshold value and termination of the process when the threshold is met. In other words, a target value is preset ahead of time, and when the target value is reached, the process is completed. By contrast,

the present invention, as specifically claimed in both independent claims 1 and 9, involves the continuing of the evolutionary process, not for a fixed, predetermined number of generations, nor until a fixed, predetermined value is reached, but instead, it continues until the fitness function of the rules cannot be further improved, i.e., becomes substantially constant, indicating the reaching of the plateau. This definition of "plateuing" is supported in the specification, e.g., at page 6, lines 18-19 and at page 12, line 8. The quoted sections of the specification make it clear that plateuing continues <u>not</u> until a fixed threshold level is met (as in Hung) but instead, until the fitness function "ceases to improve" and "becomes substantially constant."

As an example of the differences, it is conceivable that using the Hung process, the threshold level will be reached after a single evolutionary process step, and that if additional evolutionary process steps were performed, additional improvement would occur. However, since Hung relies upon a threshold level, these additional improvements will never be realized. To illustrate the differences, consider the process used to progress children through a school system. The Hung patent would be comparable to a system whereby, if a second grader spends 180 school days attending second grade, they are automatically advanced to the third grade. The 180 days represents the fixed, predetermined threshold of the Hung invention. It allows the child to be progressed to third grade, regardless as to whether or not their level of knowledge and skill has been increased to the level necessary to succeed in third grade. By contrast, the present invention is analogous to a system whereby a student is taught subject matter, and then tested on it, and continues with this teaching/testing process until the

testing indicates that the child has achieved a level which will allow them to be successful in third grade. For one child that might be completed in 30 days, for another child it might be 180 days, and for another child it might be 300 days. The number of generations will vary depending upon at what point the student "plateaus" at a level where they are able to succeed in the next grade level. Obviously the number of generations in the latter example will not be infinite; however, it is variable in nature and is not predetermined, in contrast to the constant, predetermined number of generations used by Hung.

By focusing on plateauing, as is done in the present invention, the process proceeds until there is no apparent value to continuing. This is significantly different from the Hung reference and results in the potential for much improved results. These elements are specifically claimed in the present invention, and thus all of the claims are allowable over Hung.

B. The Examiner improperly rejected claims 9-20 under 35 U.S.C. §103(a) as being unpatentable over Hung in view of Chidambaran et al. (IEEE 98th8367).

In item 11 on pages 10-14 of the final Office Action, the Examiner rejected claims 9-20 under 35 U.S.C. §103(a) as being unpatentable over Hung in view of Chidambaran et al. (IEEE 98th8367).

The addition of Chidambaran does not teach or suggest the plateauing evolution process claimed in each of the independent claims herein. Without such teaching or

suggestion, it is improper to reject the claims based upon the proposed Hung/Chidambaran combination proposed by the Examiner.

10. CONCLUSION

For the foregoing reasons applicants respectfully request this Board to overrule the Examiner's rejections and allow claims 1-20.

Respectfully submitted:

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APPENDIX A

CLAIMS INVOLVED IN THIS APPEAL:

1. A method for deriving an optimized rule set for a fuzzy logic system, said method comprising the steps of:

generating a pool of random rules having a fitness function and storing said random rules;

evolving said random rules using a genetic algorithm to improve the fitness function of said rules in said random rule set until the overall fitness function of said rules plateaus, thereby generating an optimized rule; and

storing said optimized rule in an optimized rule storage area, said rules stored in said optimized rule storage area comprising said optimized rule set.

2. A method as set forth in claim 1, wherein said generating step includes the steps of:

checking said optimized rule storage area to determine if it contains any optimized rules; and

using any optimized rules contained in said optimized rule storage area when generating said pool of random rules.

3. A method is set forth in claim 1, wherein said evolving step comprises evolving the features of said random rules.

4. A method is set forth in claim 1, wherein said evolving step comprises evolving the qualifiers of said random rules.

5. A method is set forth in claim 1, wherein said evolving step comprises evolving the operators of said random rules.

6. A method is set forth in claim 1, wherein said evolving step comprises evolving the features, cases, qualifiers, and operators of said random rules.

7. A method as set forth in claim 1, wherein said generating, evolving, and storing steps are repeated until a predetermined number of rules are stored as said optimized rule set.

8. A method as set forth in claim 7, wherein said repeating of said steps occurs on a real-time basis.

9. At method for deriving an optimized rule set for a fuzzy logic system for use in stock market analysis, said method comprising the steps of:

generating a pool of random rules having a fitness function and storing said random rule;

evolving said random rules using a genetic algorithm to improve the fitness function of said rules in said random rule set until the overall fitness function of said rules plateaus, thereby generating an optimized rule;

storing said optimized rule in an optimized rule storage area, said rules stored in said optimized rule storage area comprising said optimized rule set;

applying a stock market data set to said optimized rule set; and

outputting a stock market analysis result based on the application of said stock market data set to said optimized rule set.

10. A method is set forth in claim 9, wherein said evolving step comprises evolving the features of said random rules.

11. A method is set forth in claim 9, wherein said evolving step comprises evolving the qualifiers of said random rules.

12. A method is set forth in claim 9, wherein said evolving step comprises evolving the operators of said random rules.

13. A method is set forth in claim 9, wherein said evolving step comprises evolving the features, cases, qualifiers, and operators of said random rules.

14. A method as set forth in claim 9, wherein said generating, evolving, and storing steps are repeated until a predetermined number of rules are stored as said optimized rule set.

15. A method as set forth in claim 14, wherein said repeating of said steps occurs on a real-time basis.

16. A method as set forth in claim 9, wherein said stock market data set comprises data regarding a particular stock choice.

17. A method as set forth in claim 9, wherein said stock market data set comprises data regarding a particular stock market.

18. A method as set forth in claim 9, wherein said stock market data set comprises data regarding comprising a particular segment of stocks.

19. A method as set forth in claim 9, wherein said stock market data set comprises data regarding comprising mutual funds.

20. A method as set forth in claim 9, wherein said stock market data set comprises data regarding comprising futures.